MODEL 6003-EA

GENERAL RESISTENCE INCORPORATED

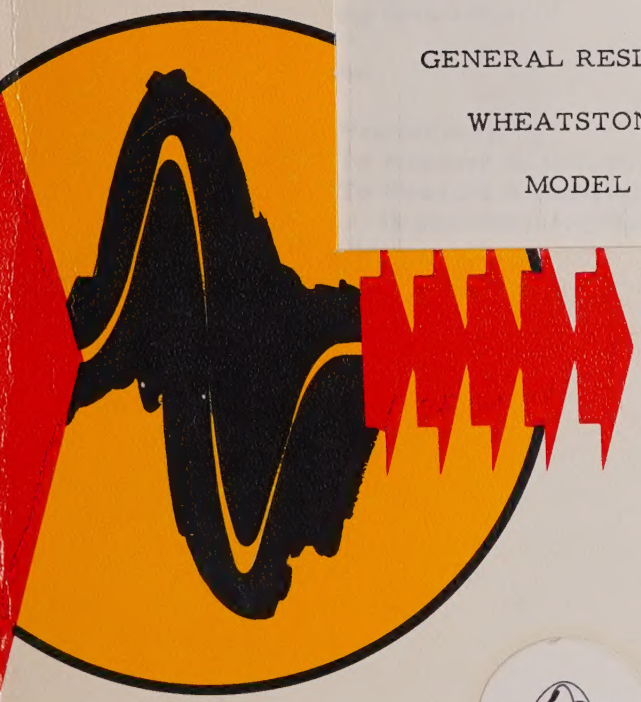
3-C-017

COMPONENTS
NETWORKS
INSTRUMENTS

GENERAL RESISTANCE, INC.

WHEATSTONE BRIDGE

MODEL 6003-EA



RESISTANCE

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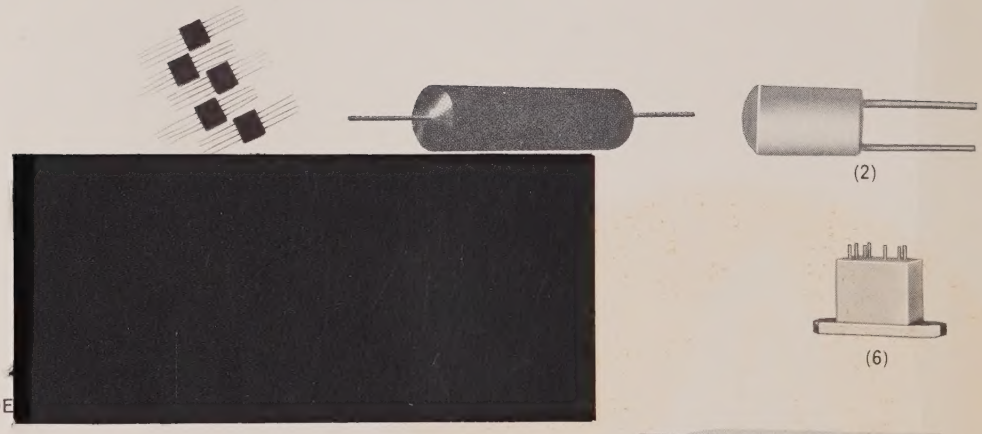
GENERAL RESISTANCE Products Include....



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RESISTORS

PRECISION WIREWOUND RESISTORS (1)
HI-REL WIREWOUND RESISTORS
RESIT-O-STATS (3)
SQUARISTORS
PRINTED CIRCUIT COMPONENTS (2)
MINIATURE RESISTANCE TEMPERATURE DE

NETWORKS

D to A CONVERTORS (4)
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TWIN-T FILTERS
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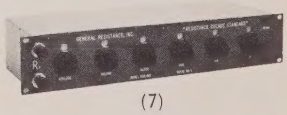
VOLTAGE DIVIDERS
LADDER NETWORKS (6)
POWER SUPPLY REFERENCES
COLD JUNCTION COMPENSATORS



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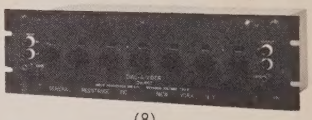

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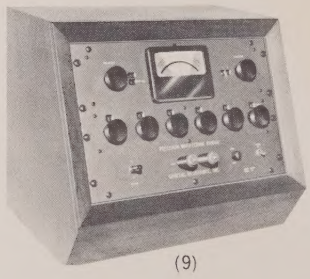
INSTRUMENTS

RMS 625 RESISTANCE MEASUREMENT SYSTEM
6003E - WHEATSTONE BRIDGE (9)
RDS 615 - DECADE RESISTANCE STANDARD (7)
VRS 101 - VOLTAGE RATIO STANDARD (12)
DIAL-A-VOLT - DIALABLE VOLTAGE REFERENCE (11)
DIAL-A-VIDER - VOLTAGE DIVIDER (14)
DIAL-A-VIDER (BENCH MODEL) (17)
DIAL-A-STAT - DIALABLE RESISTANCE DECADES (15)
DIAL-A-STAT - MILITARY (16)
TRANSFER STANDARD (13)
DECADE RESISTANCE TRANSFER SETS
1 PPM VOLT/RATIO DIVIDER (8)
GUARDED WHEATSTONE BRIDGE (10)



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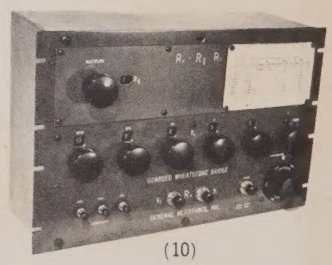

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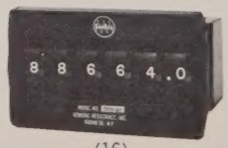

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ISSUED JULY 1, 1966

WHEATSTONE BRIDGE

RESISTANCE MEASUREMENT SYSTEM

INSTRUCTION MANUAL

GENERAL RESISTANCE, INC.

WHEATSTONE BRIDGE

MODEL 6003-EA

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1. SPECIFICATIONS

1.1 ACCURACY AND SENSITIVITY

Accuracy and sensitivity specifications are shown in Table #1.

1.2 DECADE SPECIFICATIONS

The six dial rheostat is variable from 10, 000Ω to 111, 111Ω in 0.1Ω steps. All 10, 000Ω resistors in the first decade of the rheostat and the 1, 000Ω resistors in the second decade on the rheostat are guaranteed accurate to better than .0015% and are individually temperature compensated to one PPM/°C or better. Subsequent decades are sufficiently accurate and stable to maintain total decade accuracy to better than .0015%. Switch-contact resistance is less than .001Ω per switch. For six decades, therefore, total switch resistance will equal .006Ω which is equivalent to a worst case error of one-half part per million with the decade set at the lowest resistance value (10, 000Ω). Switch error will be even lower at other resistance values.

1.3 RATIO ARM SPECIFICATIONS

All ratios consist of resistors matched to ±1/2 ppm/°C temperature coefficient. The ratios of .01, .1, 10 and 100 are guaranteed accurate to 10ppm (.001%). While the resistors used in the .001 and 1000 ratios will meet the above specifications, the switch-contact resistance in series with the 100Ω ratio arm adds an error of .001%. Because of this, the .001 and 1000 ratios are guaranteed to .003%. Since bridge sensitivity is reduced by a factor of 10 to 1 for these ranges, the effect will not be noticeable.

1.4 GENERAL SPECIFICATIONS

Resistance Range of Ohms	Guaranteed Accuracy From +20° to +30°C	Maximum Null Detector Sensitivity (1/5 dial division)	Maximum Voltage Across Unknown Resistor	Range of power dissipation in Measured Resistor		Full Scale Sensitivities in Percent
				Min.	Max.	
1-11.1111	±.005% +1 MILIΩ	100 PPM	7 Milivolts	.005 MW	.05 MW	1;2.5;5;10
10-111.111	±.005% Absolute	10 PPM	.07V	.05 MW	0.5 MW	.1;.2;.5;1;2.5;5;10
100-1.11111K	±.0025% Absolute	1 PPM	.67V	0.5 MW	5.0 MW	.01;.02;.05;.1;.25;.5;1;5;10
1K-11.1111K	±.0025% Absolute	1 PPM	.74V	.05 MW	0.5 MW	.01;.02;.05;.1;.25;.5;1;5;10
10K-111.111K	±.0025% Absolute	1 PPM	1.35V	.03 MW	0.3 MW	.01;.02;.05;.1;.25;.5;1;5;10
100K-1.11111 Meg	±.0025% Absolute	1 PPM	7.1V	.05 MW	0.5 MW	.01;.02;.05;.1;.25;.5;1;5;10
1 Meg 11.1111 Meg	±.0025% Absolute	1 PPM	67V	0.5 MW	5.0 MW	.01;.02;.05;.1;.25;.5;1;5;10
10 Meg 111.111 Meg	±.005% Absolute	10 PPM	67V	.05 MW	0.5 MW	.1;.2;.5;1;2.5;5;10
100 Meg 1111.11 Meg	±.01% *	100 PPM	67V	.005 MW	.05 MW	1;2.5;5;10

0 – 1Ω use Range extender accessory Model XR100. *

The above accuracies are guaranteed over the temperature range of 20°C. to 30°C. (68°F. to 86°F.)

*The accuracy is modified by the shunting leakage resistance of 10^{12} ohms.

2. DESCRIPTION

The GENERAL RESISTANCE Model 6003EA Bridge is a completely self contained instrument of high accuracy, suitable for both Laboratory and Production use.

The controls are as simple and foolproof.

There are 6 rheostat dials. All numbers are concealed except the desired ones, which are read in one straight line. The setting of the ratio arms is displayed on a similar concealed dial as a multiplier. The design of the bridge is such that all six rheostat dials are active at all times. Each dial controls ten resistors, thus providing overlap for additional operating convenience and to permit cross checking of dials against each other.

All resistors are specially built high accuracy, low temperature coefficient units, of exclusive GENERAL RESISTANCE design, sealed in epoxy resin. The ones in the first two decades have controlled temperature coefficients. The ratio arms are designed such that their T. C.'s are practically identical. The accuracy of ratio is so high that errors from this source may be neglected even in the most exacting work.

The dial switches are of the highest quality obtainable, with silver studs, silver alloy brushes, enclosed construction and are lubricated for life. Contact resistance is extremely low and constant. Insulation leakage is very low and, in addition precautions have been taken to reduce the effects of even this low leakage.

The bridge is powered by long life mercury batteries contained inside the cabinet which, when necessary, are easily replaced. The bridge may be serviced annually, including battery replacement, at a nominal charge.

Voltage applied to the bridge is automatically selected by the Multiplier dial to provide the correct voltage for each range of resistance valves being measured.

The bridge is operated by a single reversing key, non-locking, which obviates any possibility of accidentally leaving the battery on for any extended time. The use of this single key also insures that any leakage or thermal voltages in the external circuit under test will be balanced out by the operator in the normal manipulation of the bridge.

The self contained readout indicator is a highly sensitive-solid state chopper amplifier and meter which is accurately calibrated and is an integrated part of the GENERAL RESISTANCE SYSTEM of production testing. Besides acting as a conventional null indicator, it can be used to interpolate between steps of the .1Ω dial and can be set to read GO-NO-GO over a wide range of tolerances by turning the % SELECTOR know. Its maximum sensitivity is ±.01% full scale (to the shaded area) and each division represents .0005% (5 parts per million). This sensitivity is CALIBRATED and does not vary for measurements of ANY value between the limits of 100Ω and 11.1111 megohms.

In the ranges of 10 to 111.111Ω and 10 megohms to 111.111 megohms, the maximum sensitivity is .1% full scale *(to the shades area) and .005% (50 parts per million) per division. This change of sensitivity is indicated on the multiplier dial which specifies in which window the % selector is to be read.

It is, therefore, a simple matter to rapidly set up the bridge for production limit testing; no calculations being required.

The panel controls for the readout indicator consist of the Power Switch, Range Selector (calibrated in % deviation) and Zero Adjuster. The Zero Adjuster is used to compensate for thermal and other stray noise voltages.

Heavy duty binding posts mounted on low leakage standoff insulators are provided for connecting the test resistor. These posts are very satisfactory for general use. For Production testing, adaptors may be added to permit more rapid handling of the test resistors. The use of the preset, limit-reading mode of operation with single reversing key and a suitable Production binding post adaptor will provide the maximum speed with no loss of accuracy.

*The full scale sensitivity for the range of 1 ohm to 11.1111 ohm and for the range of 100 Meg to 1111.11 Meg is 1%.

3. UNPACKING INSTRUCTIONS

TO UNPACK BRIDGE:

1. Break three (3) sealed edges on the top side of the cardboard carton.
2. Lift up the four (4) flaps.
3. Remove top layer and four (4) side cushions of rubberized hair.
4. Carefully remove inner cardboard carton. Weight is approximately 70 pounds. Keep top side up after removal from first cardboard carton.
5. Repeat steps 1 and 2 for inside carton.
6. Remove loose kimpack.
7. Push hands down between the cardboard carton and the two flat sides of the bridge (there are no staples or nails to injure the hands). Remove the bridge from the carton by pulling the bridge up from the carton.
8. Remove or unwrap the kimpack from the bridge.
9. Use clean low pressure air or soft hair brush to remove lint and dust from front panel.
10. Use soft cotton cloth and or clear simonize on the walnut cabinet.

4. OPERATION

4.1 PRELIMINARY

Plug power cord into a source of 120 volt AC power, turn power switch on and allow one or two hours minimum warm up for maximum accuracy.

During any period of use, it is recommended that the electronic indicator be left turned on continously and not shut off after each measurement.

4.2 TO MEASURE AN UNKNOWN RESISTOR

Connect resistor to the R_x terminals of the bridge, using lead wires of lowest practical resistance.

Set % SELECTOR know to 10% (low sensitivity). Rotate the first rheostat knob to a reading of "1" and the other rheostat knobs to a reading of "0".
The six dials will now read "10, 000. 0".

Set MULTIPLIER knob to read ". 001" and depress BATTERY key downward (in the plus direction).
If the unknown resistor is larger than 10 Ω, the meter will deflect towards the right (positive direction).

Shift the MULTIPLIER knob to ". 01" and again depress the BATTERY key. Continue with successively increasing Multipliers until a point is reached where the meter deflects in the opposite direction (left, negative). Then back down one step on the MULTIPLIER knob. Now advance the first rheostat knob one step at a time, depressing the key at each step, until a point is reached where the meter again reads left. Back down one step. Repeat same process with the second rheostat knob, and then successively with the third, fourth, fifth and sixth. During this manipulation, the meter deflections will begin to become smaller. When this occurs, the sensitivity of the meter should be advanced by rotating the % SELECTOR knob as required to maintain a comfortable large deflection.

The object of this procedure is to find a setting of the MULTIPLIER and RHEOSTAT knobs such that the meter reading can be brought as close as possible to Zero using the highest sensitivity of the meter. If the meter is brought exactly to zero reading, the bridge is said to "balanced". If the meter shows a slight residual reading, the bridge is "approximately balanced".

When the bridge is balanced, the resistance of the unknown resistor is equal to the figures which appear in the six windows of the Rheostat dials multiplied by the figure which appears in the window of the MULTIPLIER dial.

EXAMPLE: The MULTIPLIER dial reads "10". The Rheostat read "31, 245. 6". The value of the unknown resistor is then equal to 31, 245. 6 times 10, or 312, 456 ohms.

With experience, it will be possible to anticipate the effect on the meter of turning the Rheostat knobs. The knobs can be turned several steps at a time, thus speeding up the balancing procedure.

When measuring an unknown resistor by the procedure outlined above, there may be instances where the bridge does not respond in the manner described.

If, when making the first reading with the MULTIPLIER set to ". 001" it is found that the meter deflects to the left, then the resistor is below 10 ohms and no balance can be obtained. Such a resistor can be measured by the method described later for low value resistors.

If the meter deflects to the right for all MULTIPLIER settings right up to the highest setting of "1000", the unknown resistor is above 10 megohms. It may still be possible to obtain a balance by manipulation of the rheostat knobs if the resistor is not higher than 111. 111 megohms. If no balance can be obtained, the resistor is above 111. 111 megohms and may be measured indirectly by a method described later.

4. 3 TO MEASURE A RESISTOR WHOSE VALUE IS APPROXIMATELY KNOWN (Short Method)

Connect the resistor to the Rx terminals. Set the MULTIPLIER as shown in the following table for the range in which the resistor falls:

RESISTOR			MULTIPLIER SETTING
1	to	11. 1111	. 0001
10	to	100 ohms	. 001
100	to	1000 ohms	. 01
1000	to	10K	. 1
10K	to	100K	1
100K	to	1 Meg	10
1 Meg	to	10 Meg	100
10 Meg	to	111. 111 Meg	1000
100 Meg	to	1111. 11 Meg	10000

Set the first several dials of the Rheostat to the approximate value of the resistor. If the resistance is known to 2 figures, use the first two dials. If known to 3 figures, use the first 3 dials, etc., with remaining dials at zero. These preliminary settings are not critical.

Set the % SELECTOR to approximately the accuracy to which the resistor is known.

Depress BATTERY key downward and observe meter. If the meter deflects to the right, rotate clockwise the last dial which was preset. If the meter deflects to the left, rotate the dial counterclockwise. If, during this rotation, the dial passes through Zero reading, move the dial immediately to its left one step in the same direction. Try to bring the meter deflection to, or just past, zero, advancing the meter sensitivity when necessary to maintain an easily observable deflection.

When the first several dials have been set correctly by this short method, the remaining dials to the right may be operated to bring the bridge to balance as described in section 4.2.

4.4 OBTAINING VARIOUS DEGREES OF ACCURACY

The use of six Rheostat dials in the above procedures will result in a precision of measurement of between 1 and 10 parts per million (.0001 to. 001%) depending on the setting of the first Rheostat dial. If high accuracy in measuring a particular resistor is not required, it is perfectly satisfactory to omit the use of the last dial, the last two dials, etc., if the remaining number of dials are sufficient to give the desired accuracy. The meter sensitivity should be turned up only to the degree necessary to obtain an approximate balance with the dials actually in use. The dials not in use may most conveniently be left set at zero. This will save time when only approximate measurements are required.

When the highest possible precision of measurement is desired, the electronic indicator should be used to interpolate between steps of the last dial. Having obtained the best balance in the conventional manner, the % SELECTOR dial should be set at the highest sensitivity (.01%) reading. The meter should now be carefully set at zero by means of the ZERO knob. This will compensate for any thermal or other stray voltages which may be acting on the circuit. Then depress the BATTERY key downward (plus) and read the meter deflection, including sign (left-negative, right-positive). This reading represents the residual bridge unbalance, expressed as a percentage of the dial reading. If the % SELECTOR is set at .01% then,

each figure on the meter scale will be in units of .001% and each division on the scale will represent .0005% (or 5 parts per million). The meter reading so obtained in % or in parts per million, must be converted to ohms and then added to (if positive) or subtracted from (if negative) the resistance read on the bridge dials.

To convert % deflection to ohms, simply multiply the reading of the bridge dials by the % shown on the meter. The resulting figure is the bridge unbalance in ohms and is added to or subtracted from the reading of the bridge dials.

When using the meter for interpolation, a slightly higher accuracy can be obtained by taking two readings of the meter; first with the BATTERY key in the positive (down) direction, and then with the BATTERY key in the negative (up) direction. The two readings are the averaged, thus eliminating error due to slight Zero offset and also somewhat increasing in precision of reading the meter scale. However, the sign on the meter reading must be taken only with the key in the positive direction.

4.5 OPERATION AS A PRODUCTION GO/NO-GO LIMIT BRIDGE

Set the MULTIPLIER to the setting in whose range the desired resistance value falls, as shown in table in Section 4.3.

Set the Rheostat dials to the exact value of resistance halfway between the desired limits.

Set the % SELECTOR dial to the desired tolerance.

Connect a sample resistor to the Rx terminals and with battery key not depressed, adjust the ZERO control to put the meter exactly on Zero.

Successively connect each rrsistor to be tested and depress the BATTERY key. Observe meter deflection. If the meter does not deflect into the shaded area on its scale, the resistor is within tolerance. If the meter deflects past the figure "10" into the shaded area, the resistor is not within tolerance.

4.6 OPERATION AS A PRODUCTION SORTING BRIDGE

Resistors may be sorted into a number of categories using the meter scale as the indicator.

Determine the highest and lowest value resistance to be sorted. Find the percentage difference and Set the % SELECTOR to most nearly match.

Set the MULTIPLIER dial to the setting in whose range the desired resistance values fall.

Set the rheostat dials to the exact value of resistance halfway between the extreme high and low limits.

Assign the exact value of resistance which shall fall into each of the desired categories. If samples are available, test each sample and note the meter reading. The trays into which the sorted resistors are placed may be marked; each with its corresponding meter reading. If samples are not available, the meter reading may be calculated easily, as the change in meter reading between its high and low limits is proportional to the change of resistance between the the high and low resistance limits.

In all types of testing, and especially in production testing, the operator should be careful to remove hands entirely from the resistor under test while the BATTERY key is being operated, or a false reading may be obtained due to the resistance of the hand in parallel with that of the resistor.

4.7 MEASURING VERY HIGH OR VERY LOW VALUE RESISTORS

To measure a resistor below 1 ohm; screw on to the R_x terminals the range extender accessory Model XR100. Set the multiplier dial at ".001". Set the most signifiant decade (left hand decade) to "1". Connect the unknown resistor across the range extender terminals.

To read resistance; ignore the digit "1" which appears in the most significant decade window (assume it to be zero). The decimal point now appears to the right of the third decade window (counting from the left).

The bridge was not primarily designed for measurement below an ohm, however, this method does permit measurement with reduced accuracy.

To measure a resistor above 1111.11 megohm; use an auxiliary resistor of as high value as possible up to 1000 megohms. The auxiliary resistor need not be accurately known but must be stable. Connect this resistor to the R_x terminals and measure its resistance accurately in the usual way. Then, without making any change, clip the unknown resistor across the same R_x terminals and measure both resistors together. The value of the unknown resistor may be calculated as follows:

Let R_x be the unknown resistor, R_a the auxiliary resistor and R_p the value of both resistors in parallel.

$$R_x = \frac{R_a R_p}{R_a - R_p}$$

4.8 PRECAUTIONS

The General Resistance model 6003 Bridge is capable if measuring resistance within its range with unsually high accuracy. However, to get consistent results, certain possible ambiguities must be resolved.

In all cases, the dial readings of the bridge are to be taken to indicate the actual value of resistance existing externally between the two bridge terminals marked R_x. This actual value may consist of the resistor which it is desired to measure, and also the resistance of the leads which connect the resistor to the bridge terminals and the contact resistances at the various terminals in the circuit. The bridge will read the sum of all these component resistances in series. When measuring resistors in the range of 1000Ω or less, it may be necessary to take these stray resistances into consideration.

For example, the resistance of number 12 wire is about .0016Ω per foot. Two test leads each a foot long will be .0032Ω. The contact resistance at each of the four binding post terminals might easily be in the neighborhood of .0002Ω, making a total of .004Ω for two test leads and four contacts.

In measuring a resistor of say 100Ω, the bridge would be presented with a resistance between its terminals of 100.004Ω instead of 100. The bridge would then read high by .004% or 40 parts per million. For higher value resistors, the effects are proportionately less. The difficulty is that, although the bridge is correctly reading the resistance which has been presented to it, the resistance which is actually being measured is not the same as the resistance which it was desired to measure.

These figures, of course, are only illustrative but they show the importance of taking care with connecting leads. A similar difficulty occurs with leakage in measuring very high resistors. Here the leakage may be due to the resistor mounting, to low resistance insulation on the test leads, to excessive moisture condensation, etc. It takes a surprisingly small degree of leakage at a resistance level of megohms to obviate the high accuracy of this bridge. Extreme precautions have been taken to minimize leakage paths within the bridge. Leakage acts like an additional resistor of high resistance and poor stability, in parallel with the resistor being measured. Again, as in the case of low resistors, While the bridge is correctly reading the resistance which has been presented to it, that resistance may not be the same as the resistance which it was desired to measure.

It is, therefore, recommended that, when measuring very high resistors, extra care be used to prevent these parallel leakage paths.

5. MAINTENANCE

The General Resistance Precision Bridge requires very little maintenance beyond occasional replacement of batteries. All resistor switches are dust sealed and lubricated for life. The bridge chassis is also sealed by a dust cover and adequate gaskets to protect the working parts.

To change tubes or batteries:

1. Remove grill from rear of cabinet.
2. Disconnect AC power cord at the rear of chassis.
3. Remove front panel-to-cabinet mounting screws.
4. Withdraw chassis through front of cabinet.
5. Remove screws from rear of dust cover and withdraw dust cover straight back.

The battery holders are now accessible.

When replacing batteries, it is advisable to replace all at the same time. Use only Everyready type EL (1. 35V) mercury cells and observe polarity. The ends of the cell containers are removed by twisting to the left to release the bayonet at spring end and then pulling straight back. When replacing, be sure each bayonet is fully engaged. Holes are provided in the containers for voltage checking.

The full battery complement consists of 50 type EL mercury cells.

While the dust cover is off, care should be taken not to apply pressure on, or handle any of the resistors, resistor cards or switches. Special care is taken in assembly to maintain very low leakage paths on all insulators and any foreign matter accumulated on the surface may become noticeable.

Figure 1 is the overall schematic of the bridge.

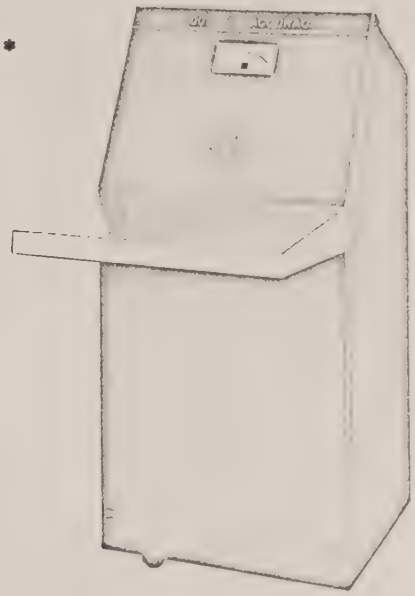
It is recommended, however, that regular maintenance be performed at the factory at periods of one year. Such maintenance would permit, in addition to regular replacement of batteries, a thorough check of bridge performance generally, and a certification of continued accuracy.

For full information on this service, please contact General Resistance, Inc. directly.

BULLETIN
710

WHEATSTONE BRIDGE

±.001% ACCURACY*



- Resistance Range — 1 ohm to 1111.11 meg ohms
- Totally self-contained resistance measurement system
- Over 7 years of proven long term stability
- GO/NO GO operation
- Automatically programs correct measurement voltage and detector sensitivity
- Automatic percent deviation readout-linear meter display
- 3 Step operation for unequalled simplicity
- Damage proof circuitry
- 8 decade resolution from 6 decades plus overranging and linear analog meter display

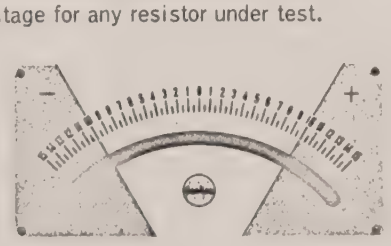
The Gen Res Model 6003EB is totally self-contained Resistance Measurement System, consisting of a wheatstone bridge, solid state null detector, regulated supply and an automatic GO/NO GO percent selector programmer. Over 600 resistors per hour can be measured and sorted to better than 1 PPM relative or ±10PPM absolute accuracy.

This new Gen Res Resistance Measurement System featuring 10 PPM accuracy was developed after 7 years of manufacturing experience in precision Bridges. This revolutionary unit is 100 times more sensitive than its predecessor and is the most accurate and sensitive RMS ever offered.

Each GR bridge prior to completion undergoes 6 months of continuous operative use by the company's personnel. During this time periodic measurements of accuracy and stability are taken. Those units which meet General Resistance's rigid standards are then prepared with the additions and replacement of cosmetic hardware (front panels, knobs, cabinet etc.)

The GO/NO GO meter reads error in percent or parts per million of the component under test. All resistors with values within the preset tolerance limits read in the (GO) area. Resistors to be rejected read in the (NO GO) portion. The percentage deviation from the nominal value can be determined directly from the scale reading. This linear meter feature of the General Resistance bridge is automatic and requires only the movement of a single percent selector knob to the desired limit, without regard to the other dial settings. The selected deviation percentage is independent of resistance value and does not have to be reset when resistance value is changed.

General Resistance's RMS contains unique damage prevention design features and unequalled simplicity of operation. An accidental or deliberate short circuit across the Rx terminals causes no damage to the bridge under any operating conditions. The resistive components being measured cannot be damaged by over voltage, regardless of the setting. These "error-proof" advantages are accomplished through the use of General Resistance's "Driven Mode" bridge circuitry. This circuitry automatically limits the voltages and current being supplied and selects the correct voltage for any resistor under test.



*MEASUREMENT AGREEMENT WITH NBS; CERTIFICATE OF CALIBRATION FURNISHED TRACEABLE TO NBS.

Gen Res
430 Southern Blvd. • Bronx, New York 10455 • Tel.: 212-292-1500 • TWX 212 824-4880

WHEATSTONE BRIDGE

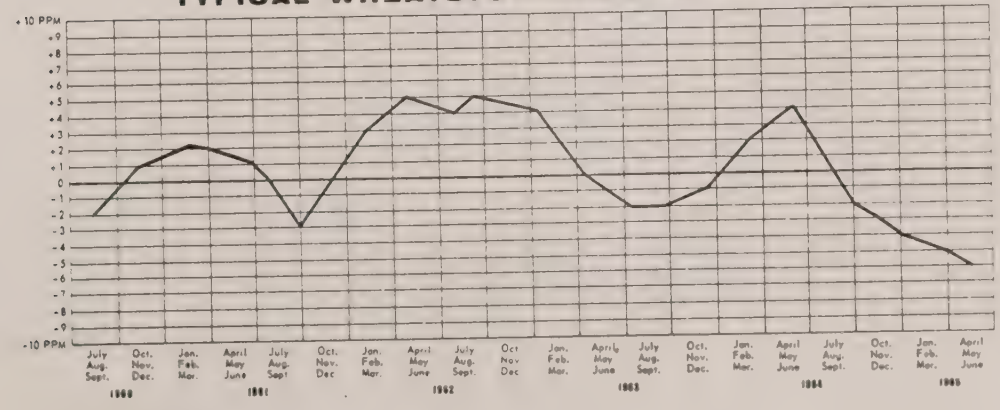
With the exceptionally low power applied across the resistor under test the RMS is ideally suited for thermistor operation. A simple modification is also available which can reduce the already low power to 1/10,000 of the original power disipated or typically 10 nano watts (10^9 watt). With this reduced power a meter sensitivity of .001% per major division is attainable.

The most sensitive range has a full scale sensitivity of ±1PPM. One part per million moves the meter needle full scale and each major division on the meter scale is equal to .1 PPM (.00001%).

Eight decade resolution is derived from six decades with overranging plus analog meter display. Meter readout is always linear and proportional to the deviation of the resistor under test from the decade arm setting. A data logging system can be directly connected to the meter to provide a completely automated system.

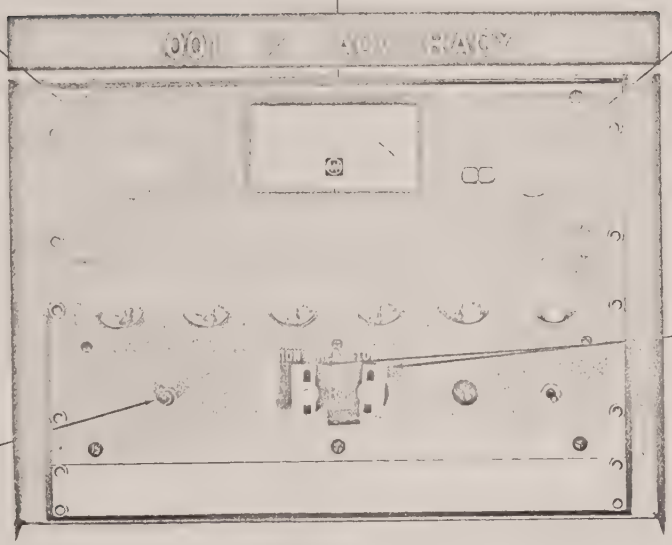
Remote measurements are easily accomplished as one of the Rx terminals is case and earth grounded. This permits use of low leakage shielded cables for remote resistance measurements. The lead resistance associated with remote measurements is quickly dialed out to allow instant performance at locations distant from bridge.

TYPICAL WHEATSTONE BRIDGE STABILITY*



*Representative of data taken on over 50 Bridges.

UNEQUALLED SIMPLICITY OF OPERATION



GO NO GO LINEAR DISPLAY
Read deviation directly in PPM or %. Max. sensitivity 0.05 PPM (.000005%) per div. ±1PPM full scale. Resolution equals 8' dials. NO GO area displays value to 50% beyond tolerance. Fast response, over 600 resistors per hour can be manually measured and sorted by tolerance.

MULTIPLIER DIAL
Locates decimal point and multiplies decade. 9 multiplier positions from .0001 to 10,000. Establishes Bridge measurement ranges from 1 to 1,111.11 meg ohms.

OHMIC VALUE DIAL (Decade Ohm)
Positive detent in five numeric display (no pots to interpolate). 10% overranging on every dial. Switch maintenance eliminated. Unique design of bridge assures that switch wear has negligable effect on accuracy.

REVERSING LEVER
Permits instantaneous reversal of applied voltage.

% SELECTOR
Instantly set any one of 15 discrete ranges of meter deflection sensitivity. Fully automatic calibration.

RX TERMINALS
Foolproof: A short will not hurt bridge.
Universal: Rapid slip clips and adaptor bars provided for rapid insertion of Resistors or Standards.
Simple: No guard circuit needed for remote operation.
Low Power: Micro watts of power across resistor under test eliminate possibility of accidental damage.

1. Set Nominal Resistance Value on dials – No potentiometers to interpolate or move
2. Set Decimal point (Multipler dial)
3. Set Automatic % selector to desired GO/NO GO range

ACCESSORIES

Universal quick insertion slip clips – No charge

Mercury Wetted Adapter Bars – for connection of resistance standards and Gen Res Transfer Standards – no charge

Model XR100 Range Extender – for measurements of resistance values below 1 ohm – $35.00

Models 103T + 105T – Transfer Standards – See bulletin #408.

SPECIFICATIONS

Resistance Range In Ohms	Models 6003E-B-D Guaranteed Accuracy From +22 To 26°C	Model 6003EC Guaranteed Accuracy From +20 To +30°C	Model 6003EB Maximum Null Detector Sensitivity Per Full Dial Division	Models 6003E-C-D Maximum Null Detector Sensitivity Per Full Dial Division	NULL DETECTOR FULL SCALE SENSITIVITIES IN PERCENT		Maximum Voltage Across Unknown Resistor	Range of Power Dissipated In Measured Resistor	
					Additional Scales on Model 6003EB only			MIN.	MAX.
1 - 11.1111	±.005% ±1 Milli Ω	±.005% ±1 Milli Ω	5 PPM	50 PPM	.01,.02,.05	.1,.2,.5,1,2,5,5,10	7 Milivolts	.005 MW	.05 MW
10 - 111.111	±.0035% Absolute	±.005% Absolute	.5 PPM	5 PPM	.001,.002,.005	.01,.02,.05,.1,1,2,5,5,10	.07V	.05 MW	0.5 MW
100 - 1.11111K	±.001% Absolute	±.0025% Absolute	.05 PPM	.5 PPM	.0001,.0002,.0005	.001,.002,.005,.01,.02, .05,.1,.25,.5,1,5,10	.67V	0.5 MW	5.0 MW
1K - 11-1111K	±.001% Absolute	±.0025% Absolute	.05 PPM	.5 PPM	.0001,.0002,.0005	.001,.002,.005,.01,.02, .05,.1,.25,.5,1,5,10	.74V	.05 MW	0.5 MW
10K - 111.111K	±.001% Absolute	±.0025% Absolute	.05 PPM	.5 PPM	.0001,.0002,.0005	.001,.002,.005,.01,.02, .05,.1,.25,.5,1,5,10	1.35V	.03 MW	0.3 MW
100K - 1.11111 Meg	±.001% Absolute	±.0025% Absolute	.05 PPM	.5 PPM	.0001,.0002,.0005	.001,.002,.005,.01,.02, .05,.1,.25,.5,1,5,10	7.1V	.05 MW	0.5 MW
1 Meg - 11.1111 Meg	±.001% Absolute	±.0025% Absolute	.05 PPM	.5 PPM	.0001,.0002,.0005	.001,.002,.005,.01,.02, .05,.1,.25,.5,1,5,10	67V	0.5 MW	5.0 MW
10 Meg - 111.111 Meg	±.005% Absolute	±.005% Absolute	.5 PPM	5 PPM	.001,.002,.005	.01,.02,.05,.1,1,2,5,5,10	67V	.05 MW	0.5 MW
100 Meg - 1111.11 Meg	±.01% Absolute	±.01% Absolute	5 PPM	50 PPM	.01,.02,.05	.1,.2,.5,1,2,5,5,10	67V	.005 MW	.05 MW

	MODEL 6003EB	MODEL 6003ED	MODEL 6003EC
ACCURACY	±.001% at +24°C ±2°C From 100 ohms to over 11 megohms. Over the full range of .1 ohm to 1111.11 megohms See Tables I & II		±0025 at +20 to +30°C
STABILITY	±5 PPM/per year max.		No drift specification is applicable since the ±0025% accuracy includes both temperature corrections and allowance for 1 years drift
TEMPERATURE	No temperature correction necessary from +22 to +26°C over the range of +15 to +22°C and +27 to +35°C total T.C. is less than ±1 PPM/per °C		Temperature correction is not applicable from +20 to +30°C
SENSITIVITY	±1 PPM full scale max. See Table I	±10 PPM full scale max. See Table I	
READOUT	Linear percent deviation automatically programmed permits GO/NO GO measurement		
RESOLUTION	One major division on the meter scale equals 0.1 PPM resolution 8 decade resolution is derived from 6 decades plus overranging and analog meter display	0.5 PPM per meter division	
SPEED	Over 200 resistors sorted per hour	Over 600 resistors sorted per hour	
RESISTANCE RANGE	1 ohm to 1111.11 megohms		
POWER	115 volts ±10%, 50 to 400 cycles		
AMBIENT OPERATING TEMPERATURE RANGE	+15 to +35° C		
DIMENSIONS	19"W x 12¼H x 11½D (less cabinet and excluding mounting face and knobs)		
SHIPPING WEIGHT	50 lbs.		
PRICE (includes walnut cabinet) Desk console cabinet add $250 all models	$3750	$3590	$3450

GenRes

WHEATSTONE BRIDGE

MODEL 6003EA

RESISTANCE MEASUREMENT SYSTEM

BULLETIN NO. 603

FEATURES

- 6 decade resolution
- Automatic percent deviation readout (GO/NO GO)
- Self - contained power supply, null detector etc.
- Ruggedized construction - designed for continuous daily use
- Proven long term stability
- Resistance Range 1Ω to 1111.11 Meg ohms
- Automatically programs correct measurement voltages

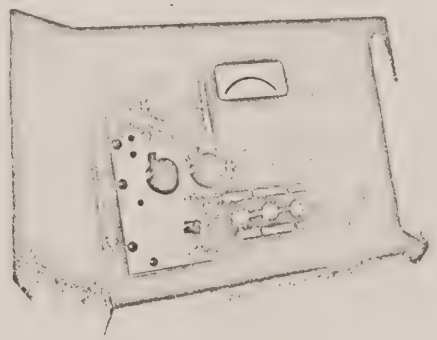
APPLICATIONS

- Standards departments
- College and environmental test laboratories
- Production line testing
- Incoming inspection areas
- Quality control
- Rapid sorting by percent deviation

±.0025%*

ABSOLUTE ACCURACY

GO/NOGO OPERATION



The General Resistance Model 6003EA is a totally self-contained resistance measurement system consisting of a wheatstone bridge, solid state null detector, regulated power supply and an automatic GO/NO GO percent selector programmer.

The new bridge offers an accuracy of ±.0025% over the resistance range of 100Ω to 11.111 meg ohms. This accuracy is an unqualified percent of actual resistance measurement, and NOT a percent of full scale. A ±.0005% accuracy (referenced to a primary standard) of actual reading can also be obtained by utilizing the Gen Res furnished calibration charts and methods.

The Gen Res bridge contains unique damage prevention design features and unequalled simplicity of operation. An accidental or deliberate short circuit across the Rx terminals will cause no damage to the bridge under any operating condition. The resistive components being measured cannot be damaged by over voltage, regardless of the setting. These "error-proof" advantages are accomplished through the use of General Resistance's "Driven Mode" bridge circuitry, which automatically limits the voltages and current being supplied and selects the correct voltage for any resistor under test.

Resistance readings can be made across six discrete in-line position decade dials. This provides positive identification of the selected resistance value and requires no interpolation of a potentiometer dial.

The GO/NO GO meter reads error in percent or parts per million of the component under test. All resistors with values within the preset tolerance read in the white (GO) area. Resistors to be rejected read in the grey (NO GO) portion. The percentage deviation from the nominal value can be determined directly from the scale reading. This limiting meter feature of the General Resistance bridge is automatic and requires only the movement of a single percent selector knob to the desired limit, without regarding to the other dial settings. The selected deviation percentage is independent of resistance value and does not have to be reset when resistance value is changed.

*AN UNQUALIFIED PERCENT OF ACTUAL RESISTANCE MEASUREMENT & NOT A PERCENT OF FULL SCALE

GENERAL RESISTANCE, INC.
430 SOUTHERN BOULEVARD, BRONX, N.Y. 10455
TEL: 212-292-1000 • TWX: 212-920-9000

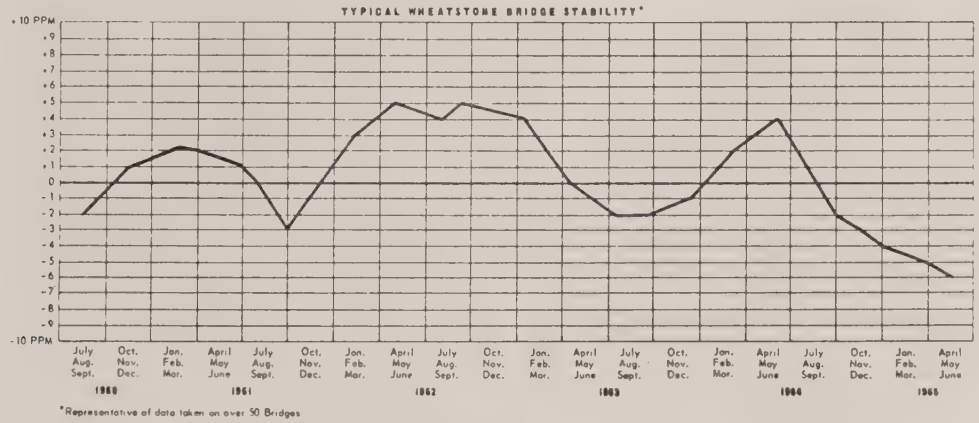
WHEATSTONE BRIDGE
MODEL 6003EA

WHEATSTONE BRIDGE
MODEL 6003EA

SPECIFICATIONS

Resistance Range of Ohms	Guaranteed Accuracy From +20° to +30°C	Maximum Null Detector Sensitivity (1/5 dial division)	Maximum Voltage Across Unknown Resistor	Range of power dissipation in Measured Resistor		Full Scale Sensitivities in Percent
				Min.	Max.	
1-11.1111	±.005% +1 MILIΩ	100 PPM	7 Milivolts	.005 MW	.05 MW	1;2.5;5;10
10-111.111	±.005% Absolute	10 PPM	.07V	.05 MW	0.5 MW	.1;.2;.5;1;2.5;5;10
100-1.11111K	±.0025% Absolute	1 PPM	.67V	0.5 MW	5.0 MW	.01;.02;.05;.1;.25;.5;1;5;10
1K-11.1111K	±.0025% Absolute	1 PPM	.74V	.05 MW	0.5 MW	.01;.02;.05;.1;.25;.5;1;5;10
10K-111.111K	±.0025% Absolute	1 PPM	1.35V	.03 MW	0.3 MW	.01;.02;.05;.1;.25;.5;1;5;10
100K-1.11111 Meg	±.0025% Absolute	1 PPM	7.1V	.05 MW	0.5 MW	.01;.02;.05;.1;.25;.5;1;5;10
1 Meg 11.1111 Meg	±.0025% Absolute	1 PPM	67V	0.5 MW	5.0 MW	.01;.02;.05;.1;.25;.5;1;5;10
10 Meg 111.111 Meg	±.005% Absolute	10 PPM	67V	.05 MW	0.5 MW	.1;.2;.5;1;2.5;5;10
100 Meg 1111.11 Meg	±.01% Absolute	100 PPM	67V	.005 MW	.05 MW	1;2.5;5;10

0 – 1Ω use Range extender accessory Model XR100. *



*Representative of data taken on over 50 Bridges

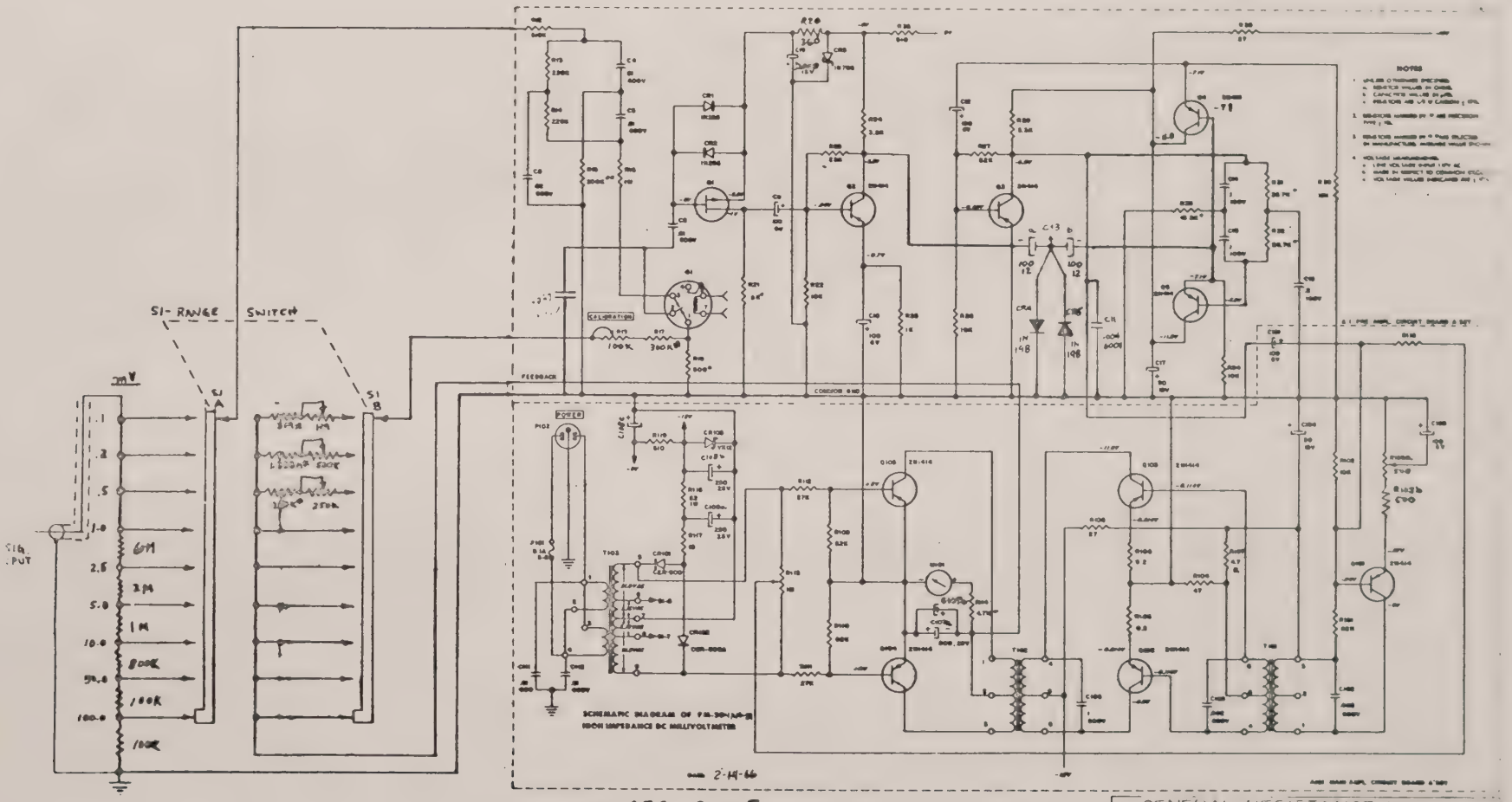
Ambient operating temperature range: +20°C to +30°C.
Power: 115 volts ±10%, 55 to 65 cps.
Weight: Net 50 lbs. Shipping 65 lbs.
Dimensions: 22-1/8" long x 18-1/2" high x 16-5/8" deep excluding mounting face and knobs.
Rack Mountable: when removed from walnut case.
Accessories supplied: slip clips for rapid resistor insertion.
*Accessories available: Model RX 100 range extender – $35. Model 100☐ Transfer Standard – See Bulletin 408.
Certification: A calibration certificate accompanies each bridge documenting initial accuracy with all measurements traceable to N.B.S.
Stability: Model 6003 EA is guaranteed to maintain the accuracy listed in table (1) for a period of one year. When used as specified, General Resistance Bridges have exhibited a typical long term stability of ±5PPM per year (See chart 1 and 11) for over six years which is generally non-cumulative.
Warm Up: The Model 6003EA is designed for continuous operation and ready for use after 60 seconds of warm up. Maximum accuracy is achieved after 2 hours.
Price: $3,250.00
Prior to shipments, a stability history is established on each bridge and is continued until the documented stability meets General Resistance rigid standards.

GUARANTEE

The accuracy of the General Resistance Model 6003EA Wheatstone Bridge is unconditionally guaranteed for a period of one year, when used as specified. This guarantee can be extended for five consecutive years by returning the unit to the factory each year for a calibration check and servicing. A nominal charge is made for this service.

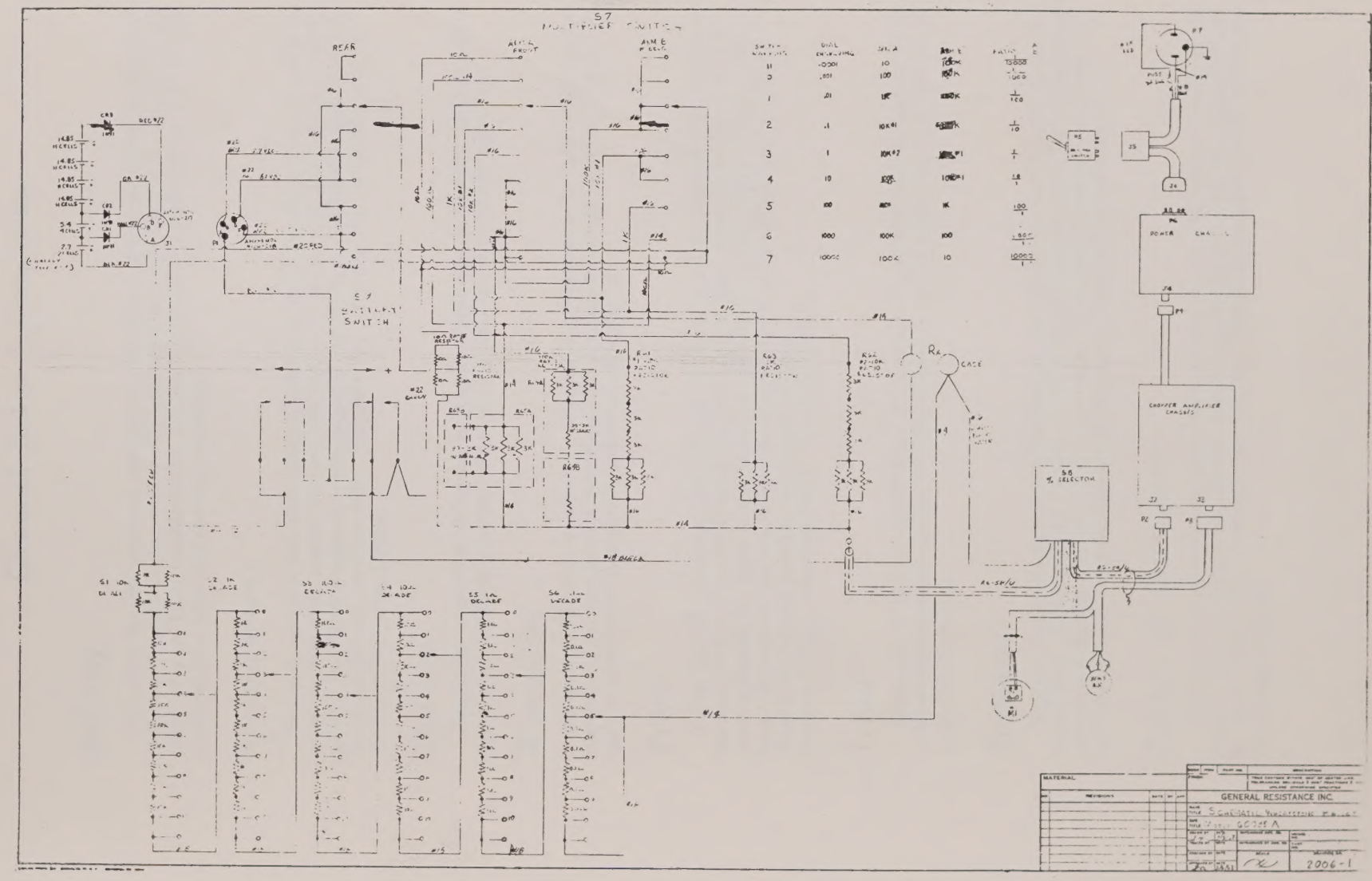
CALIBRATED ACCURACY

Over the resistance range of 100 ohms to 11.1111 meg ohms dependable accuracies as high as ±.0005% (±5PPM) of the primary standard are readily attainable using calibration charts. These charts initially supplied by General Resistance may be verified periodically by utilizing a GR Model 102T and 103T Transfer Standards referenced to primary standards.



GEN. RES. 2006

GENERAL RESISTANCE INC.	
TITLE: NULL DETECTOR AND ATTENUATOR SWITCH-GOUDSEA WHEATSTONE BRIDGE	
DRAWN BY:	DRAWING NO
APPROVED BY:	NW-SC-2005


S7
MULTIPLIER SWITCH
REAR
FRONT
ARM E
S7 MULTIPLIER SWITCH
CHOPPER AMPLIFIER CHASSIS
S6 % SELECTOR
CASE
GENERAL RESISTANCE INC.
2006-1

General Sales Information

Ordering

All orders for GRI resistors, networks or instruments should be written in the name of General Resistance, Inc. Mail to 430 Southern Blvd., New York, N.Y. 10455 or to the office of your local representative. General Resistance representatives can furnish technical data, price and delivery information.

Specifications

Standard resistors and instruments should be ordered by reference to the catalog model number. Any special features desired, such as non-standard colors or terminations, extended frequency range, special temperature coefficients etc., must be mentioned in your purchase order. Networks may be ordered by contacting your local representative or the factory.

Delivery

Reasonable quantities delivered to customer requirements. Standard deliveries are from stock to 30 days. Advance notice assures rapid delivery of large quantities.

Warranties

All General Resistance resistors, networks and instruments are fully tested before shipment and are warranted to meet their published specifications. One year guarantees apply to instruments as stated on individual data sheets.

Prices

Prices for GRI resistors, networks and instruments can be obtained from your local representative or from the General Resistance, Inc. Sales Department. There is a discount schedule for quantity purchases as well as for certain types of OEM applications. Although prices are subject to change without notice all official quotations on General Resistance products are firm for 60 days.
Minimum Billing – Per Item $5.00 – Per Order $15.00.

Terms

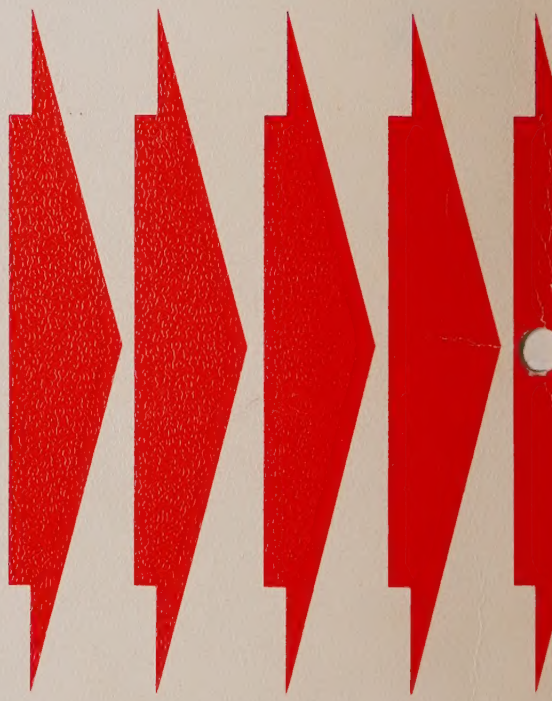
Terms are 1% 10 days–net 30 days. Shipment will be made on open account to those with established credit ratings. All other shipments will be made C.O.D. All prices are f.o.b. New York City.

Shipment

Because of our favorable location shipments can be made by registered Air Mail, Air Parcel Post, Air Freight, Air Express, truck, UPS, rail or parcel post. The recommended method will depend upon the size of your order, the urgency of your requirement. Unless you indicate a specific method GRI will ship "most economical method".

Repair of Instruments

Repair parts for all General Resistance instruments are maintained in stock at the factory. When ordering parts, please specify the serial number of the instrument and the part number. Your instrument can also be repaired and recalibrated at the factory for a nominal charge.



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